

# **X-ray Machine & Production**

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## **Intended Learning Outcomes ILO'S**

- Define radiation.
- Identify types and properties of radiation.
- Define roentgen rays.
- Discuss properties of roentgen rays
- Discuss production of x-rays
- Identify different components of x-ray machine and their functions.

# Roentgen Rays

## Roentgen Rays

### **X-rays are:**

- Pure energy units.
- Belonging to the electromagnetic spectrum.
- Have a very short wavelength.
- Can produce images of body tissues.

### **Properties:**

- Special properties
- General properties

# Special Properties of Roentgen Rays

1

- ▶ They have a very short wavelength ( $\lambda$ ).  
(0.1 Å)

Shorter wave length ----- Increase power of penetration.

## Remember

**Power of penetration depends on several factors:**

1. Wavelength.
2. Atomic number of radiographed object.
3. Thickness of radiographed object.
4. Density of radiographed object.

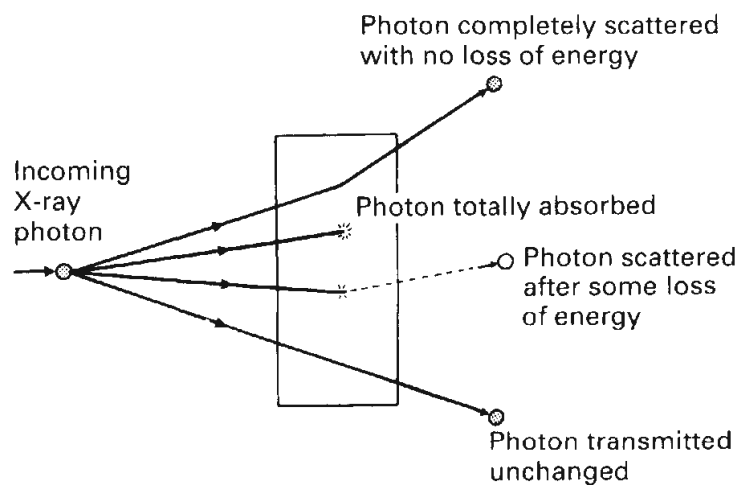
# Remember

Factor	Character	Penetration	Absorption
Wavelength	Shorter	Increase	Decrease
Atomic number	Decrease	Increase	Decrease
Thickness	Decrease	Increase	Decrease
Density	Decrease	Increase	Decrease

## Special Properties of Roentgen Rays

2

- ▶ They have a selective power of penetration and absorption.



## Special Properties of Roentgen Rays

3

- ▶ They affect photographic film emulsion.

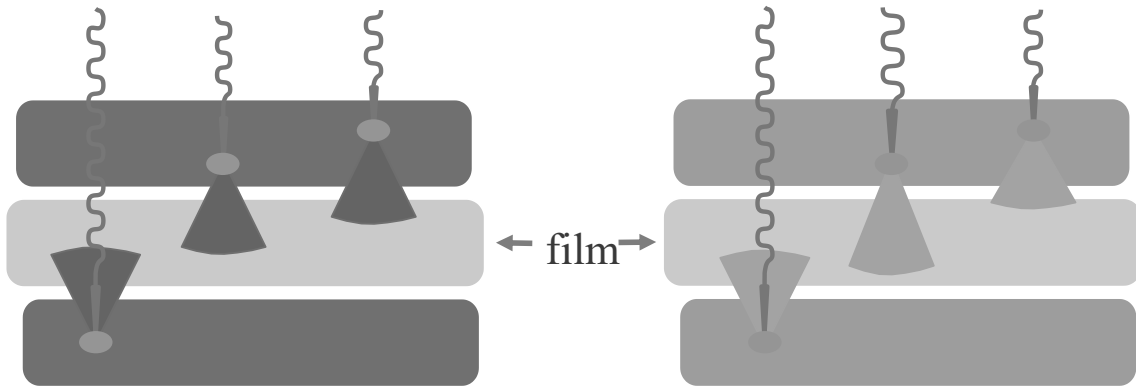
Film X-Rays latent image processing visible image

## Special Properties of Roentgen Rays

4

- ▶ It can cause certain substance to fluoresce (emit radiation of longer wavelength).

## Light Emission



● = phosphor crystal

## Special Properties of Roentgen Rays

5

- ▶ They cause ionization of atoms.

6

- ▶ X-rays cause biologic changes in living cells.

## General Properties of Roentgen Rays

- ▶ They travel in straight lines, in a wave motion with the same speed of light.
- ▶ They are invisible, can't be smelled, heard or felt.

## General Properties of Roentgen Rays

- ▶ They have no charge and no mass.
- ▶ They can't be focused by a lens.
- ▶ Can't be reflected by a mirror.
- ▶ Can't be refracted in fluids.
- ▶ Can't be deviated by a magnet.
- ▶ **Can only be deflected.**

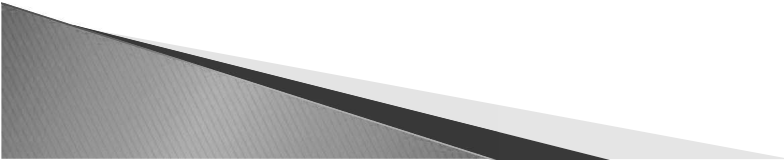
# Production of X-Rays



## Production of X-Rays

**Principle:**

**In x-ray machine we need:**

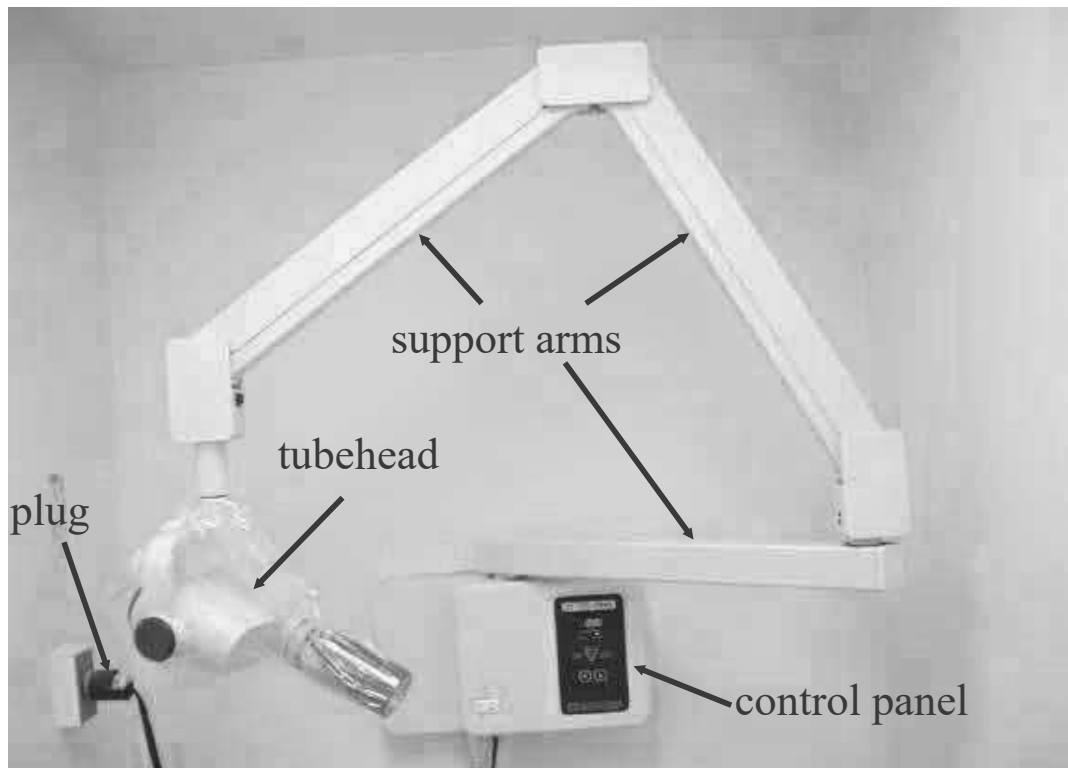
- Source of electrons (cathode filament)
  - Generating system to accelerate the electrons (transformers).
  - Anode's target ( for sudden stoppage)
- 

# X- Ray Machine

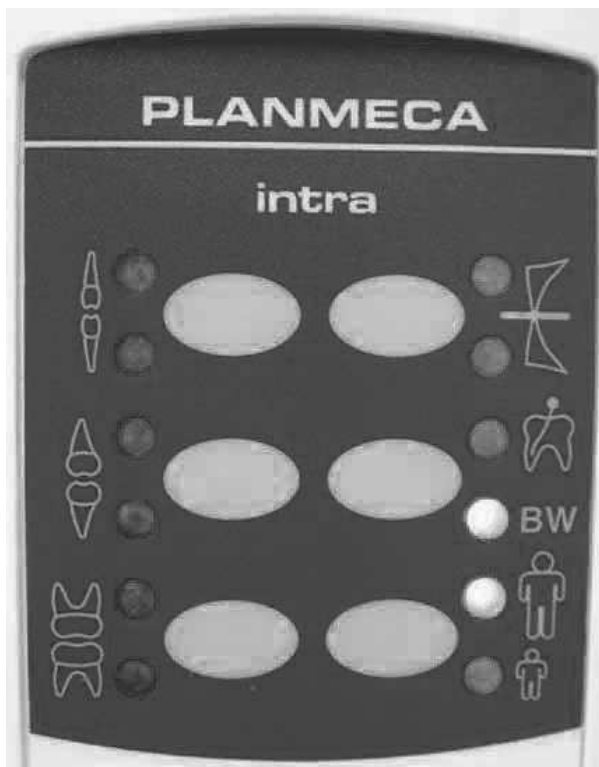
## X-Ray Machine

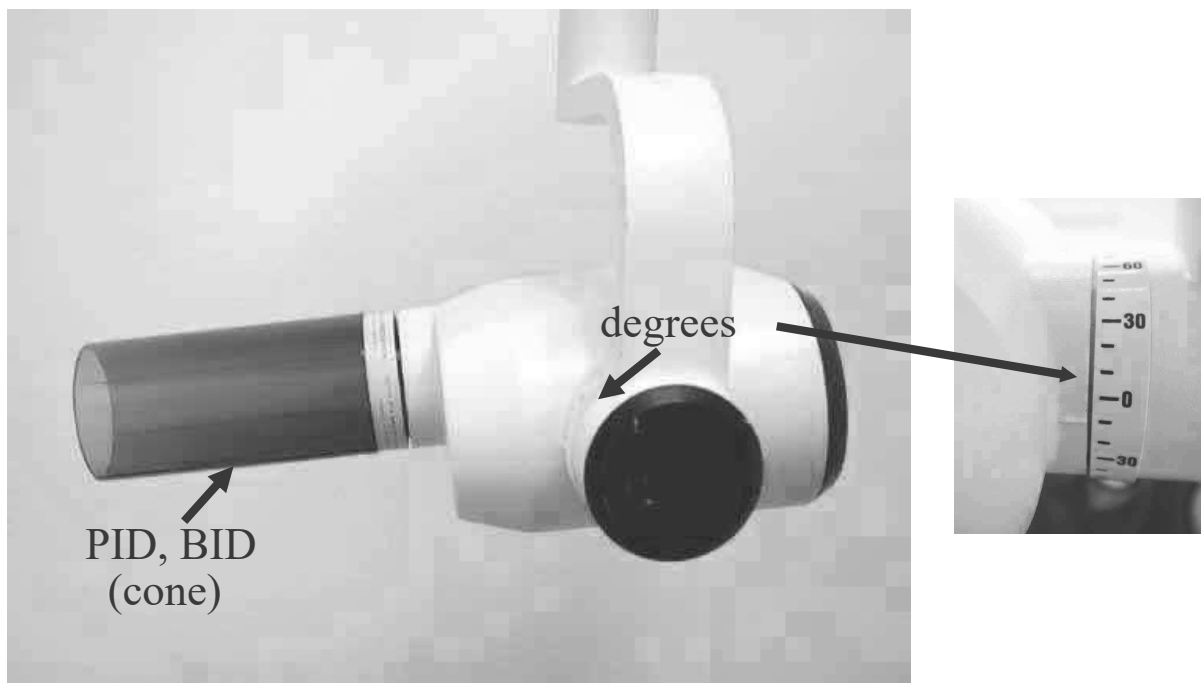
- 1.The tube-head.
- 2.The control panel & timer.
- 3.The adjusting arms.





## Control Panel



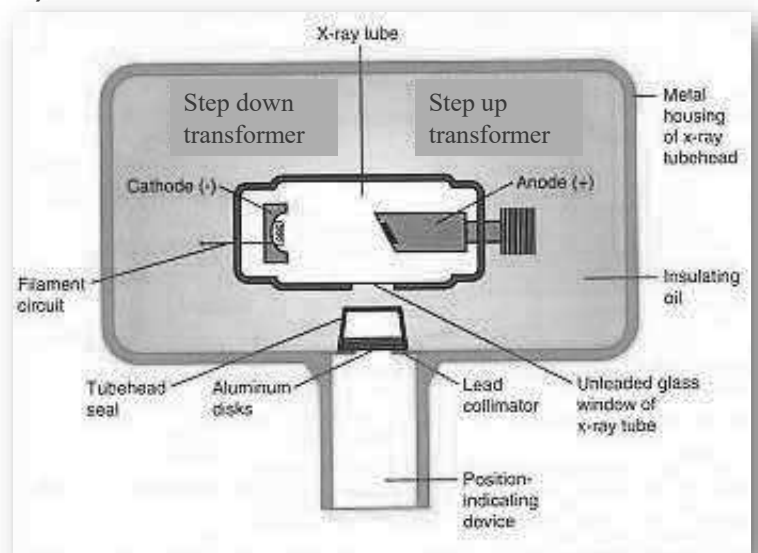


PID = position indicating device  
 BID = beam indicating device

## Tube-head

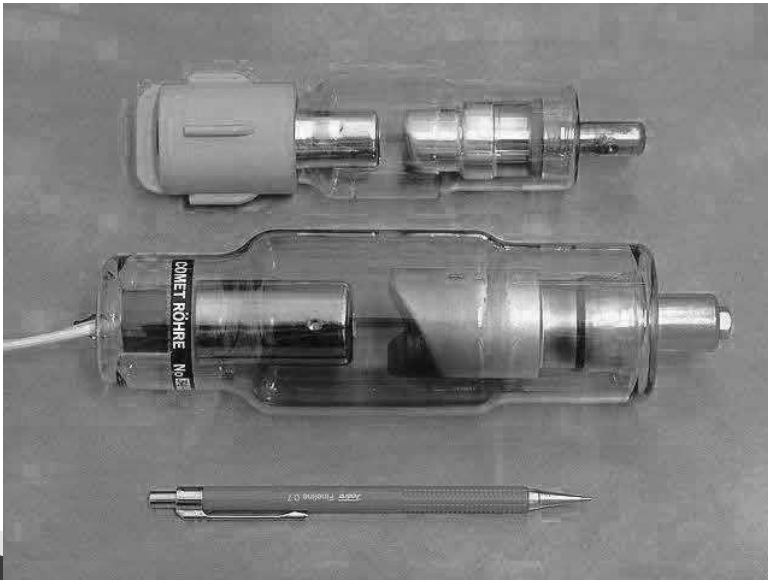
The tube-head include the following:

- ▶ The x-ray tube (main part)
- ▶ Transformers
- ▶ Insulating oil
- ▶ Metal housing
- ▶ Accessories



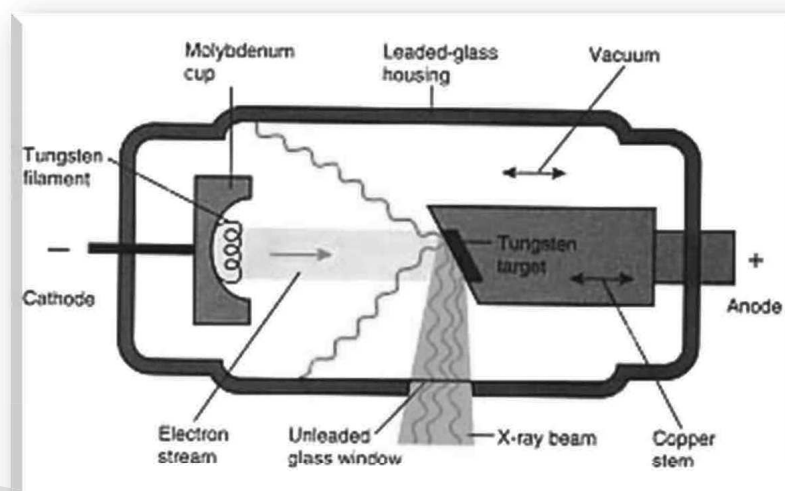
# X-ray Tube

- ▶ It is an evacuated glass tube, with two electrodes extending in two opposite directions which are the cathode and the anode.



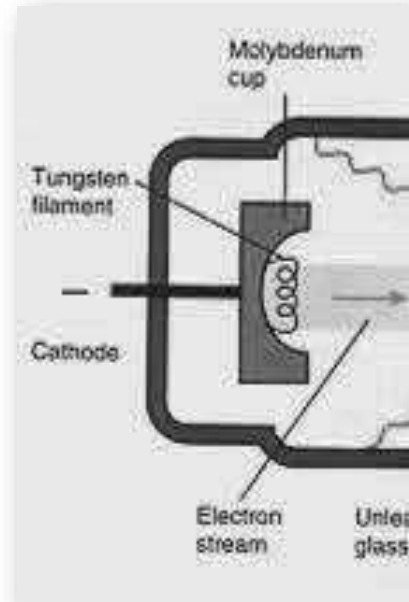
# X-ray Tube

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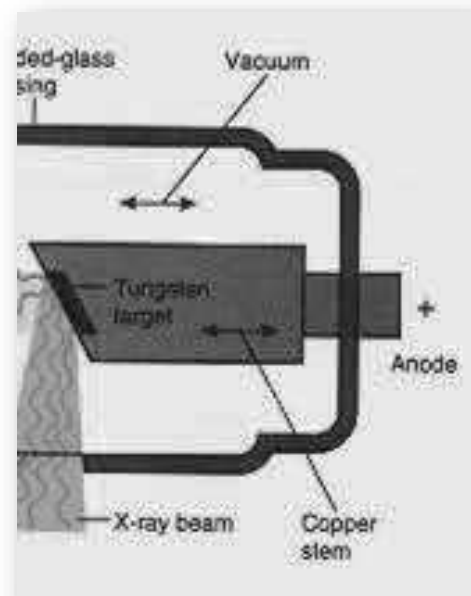
# X-ray Tube

- ▶ **The cathode:**
  - (-ve) electrode of the tube.
  - source of electrons.
- ▶ **It is composed of :**
  - tungsten filament
  - focusing cup



# X-ray Tube

- The anode:**
- (+ve) electrode of the tube.
- It is composed of:**
- target
  - copper head
  - copper arm



# Transformers

## A transformer:

- Used to increase or decrease the voltage in an electric circuit.

## Types:

- ▶ Step- down transformer (220 volt ----- 8 -12volt)
- ▶ Step- up transformer (8 -12 volt ----- 65000 volt)



## Step-Down Transformer

220 volt → 8-12volt

It's connected to the filament of the cathode



# Step-up Transformer

8-12 volt  $\longrightarrow$  65-70 KV

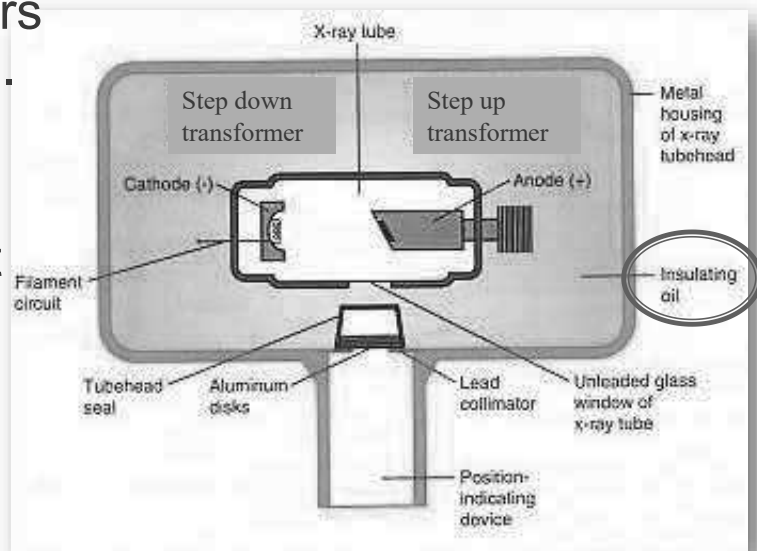
It's connected to copper arm  
(main circuit) of the anode

## The insulating oil

It surrounds the x-ray tube and transformers inside the tube head.

### Function:

- ▶ An insulator against thermal shocks.
- ▶ Cools the anode
- ▶ Filters the x-ray beam

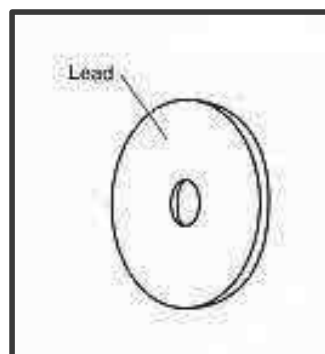


# The Metal Housing

- ▶ It is made of lead.
- ▶ It surrounds the glass tube, the insulating oil and transformers.
- ▶ It will absorb all the x-rays coming out of the generating system except for the useful beam.

## Accessories of the x-ray machine

1. **Filter.**
2. **Collimation.**
3. **Cone.**



# 1. Filter

## Added filters:

- ▶ Thin sheets of aluminum.

## Inherent filters:

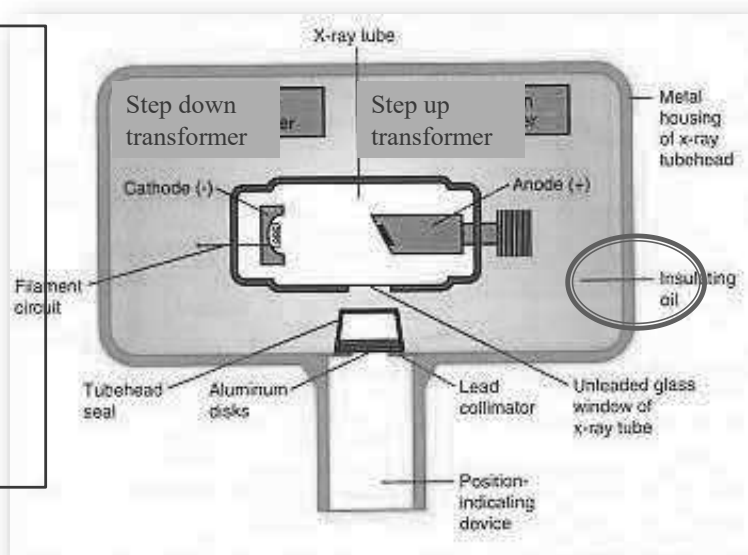
- ▶ Glass wall of x-ray tube
- ▶ Insulating oil
- ▶ The barrier material.

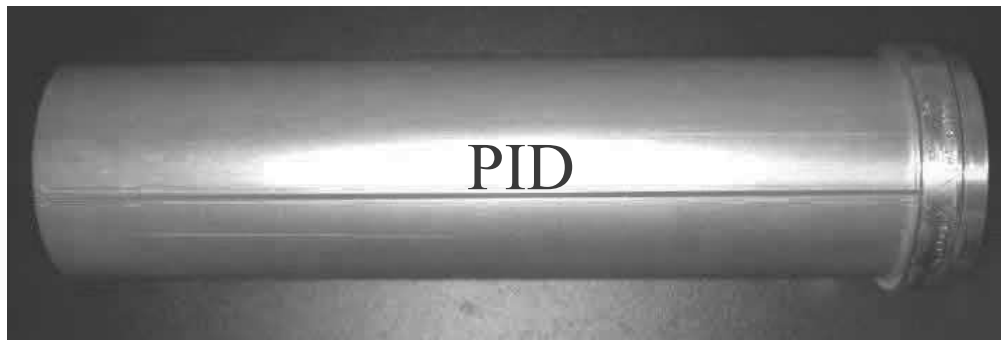
**The total filtration of x-ray tube =  
added + inherent**

# 1. Filter

## Inherent filters:

- ▶ Glass wall of x-ray tube
- ▶ Insulating oil
- ▶ The barrier material.





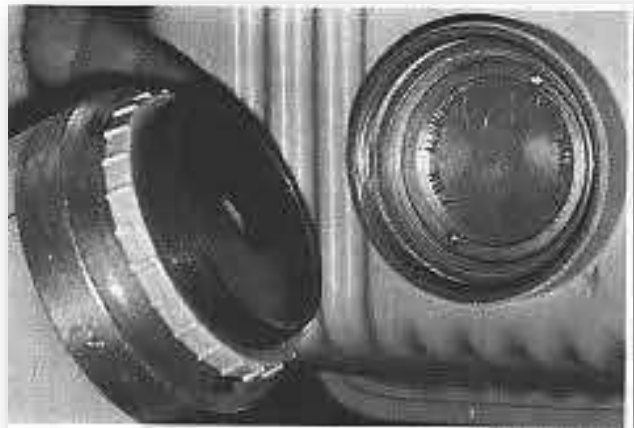
### Added filters:

- ▶ Thin sheets of aluminum.



## 1. Filter

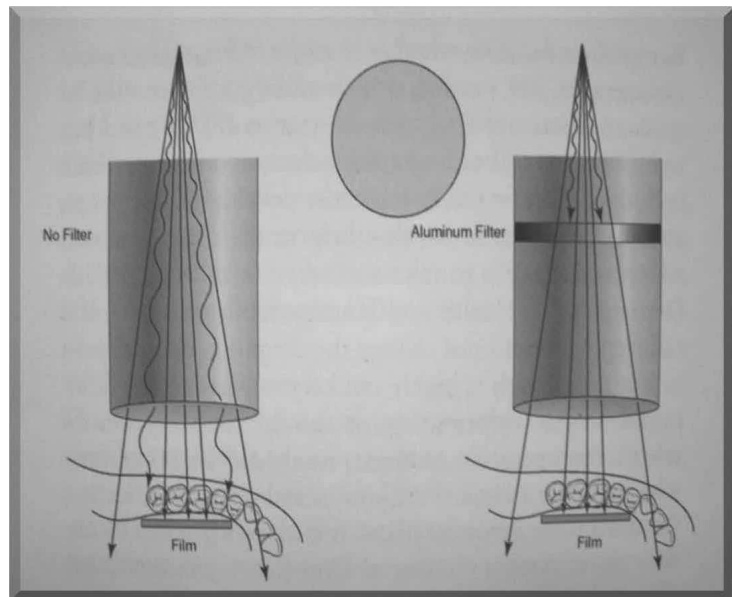
- ▶ It is thin sheet or disc of aluminum.
- ▶ Placed at the aperture of x-ray tube.
- ▶ In order to improve the quality of the beam.



# 1. Filter

► **Function:**

The x-ray beam is a heterogenous beam containing rays with longer and shorter wave length. The filter will remove rays with longer ( $\lambda$ ) and have low power of penetration.



## Remember

### Thickness:

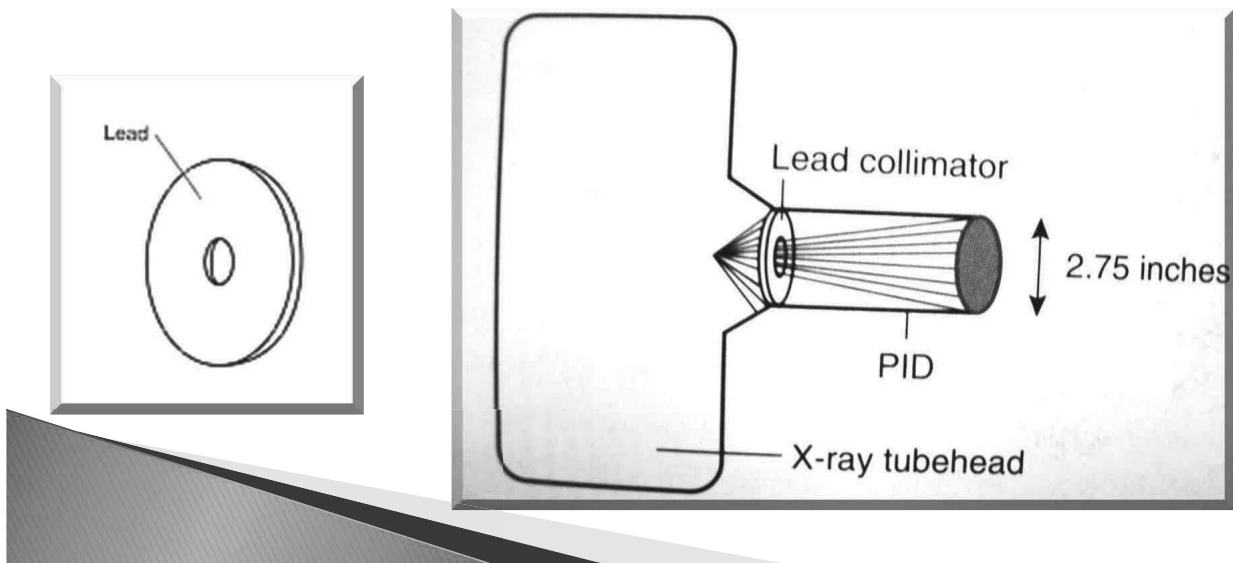
1.5 mm Al ----- 70 KVP

2.5 mm Al ----- ↑ 70 KVP

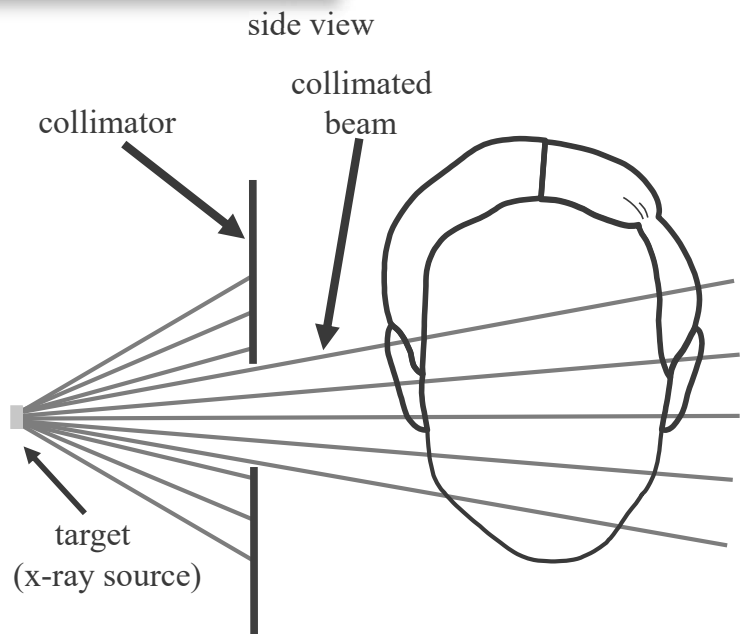
## 2. Collimator

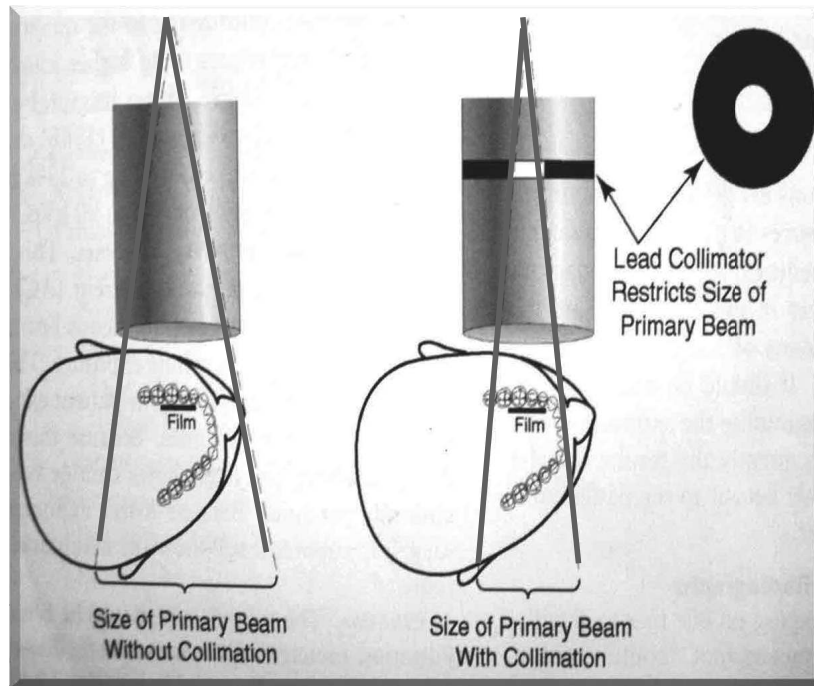
### Definition:

It is a device used to restrict the size of x-ray beam just to cover the film ( 2.75" in diameter).



## 2. Collimator

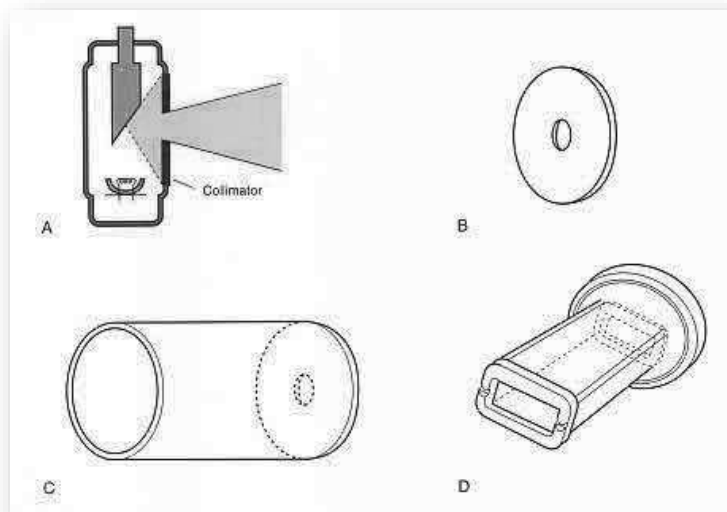


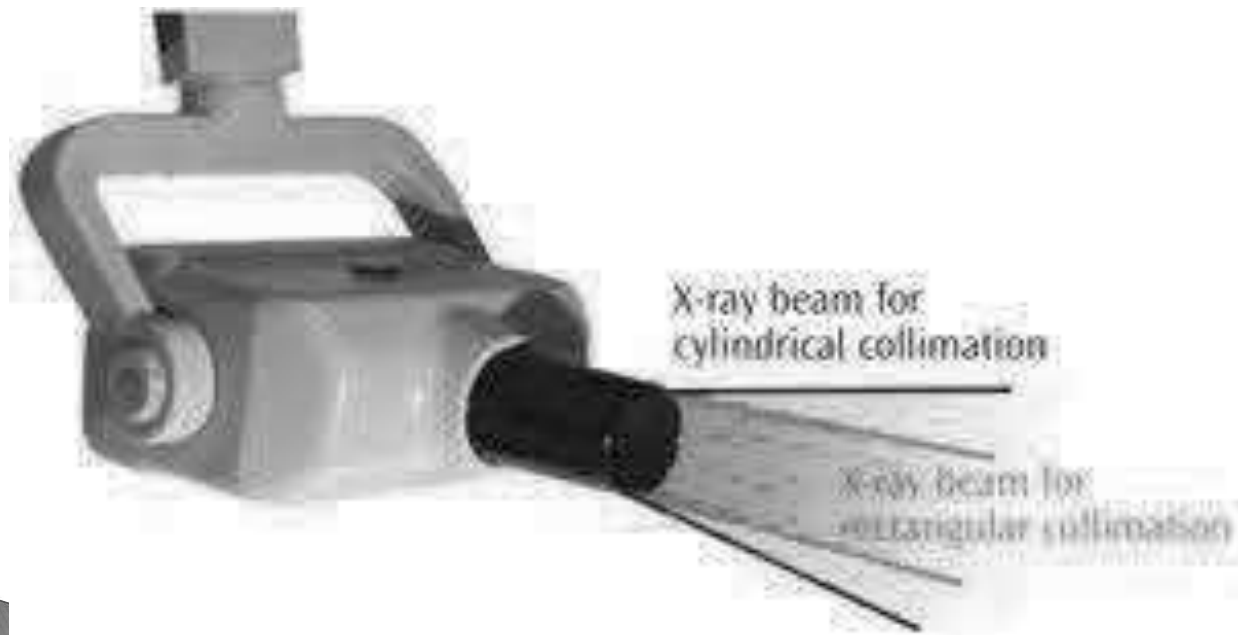


## 2. Collimator

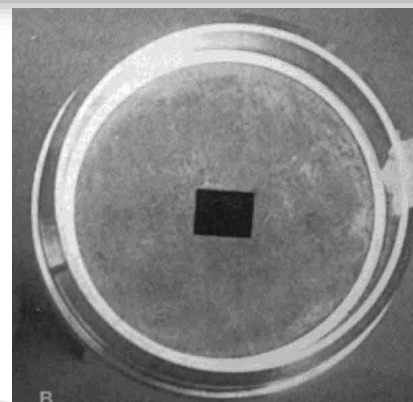
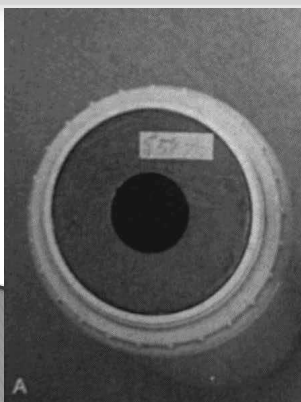
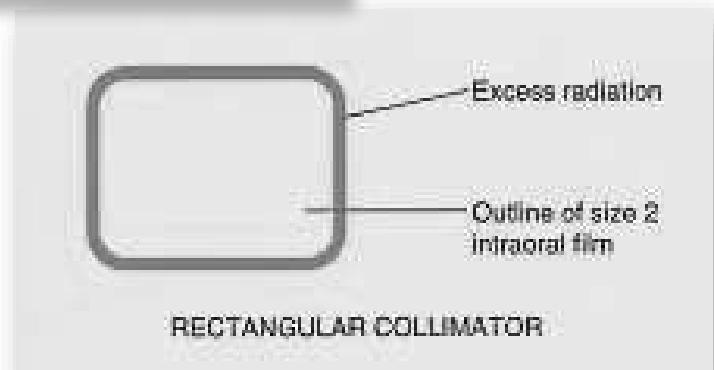
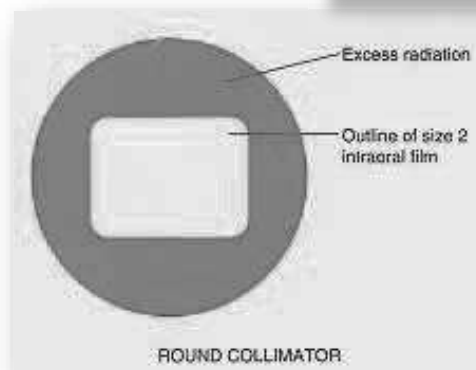
### Types:

- Diaphragm
- Tubular
- Rectangular

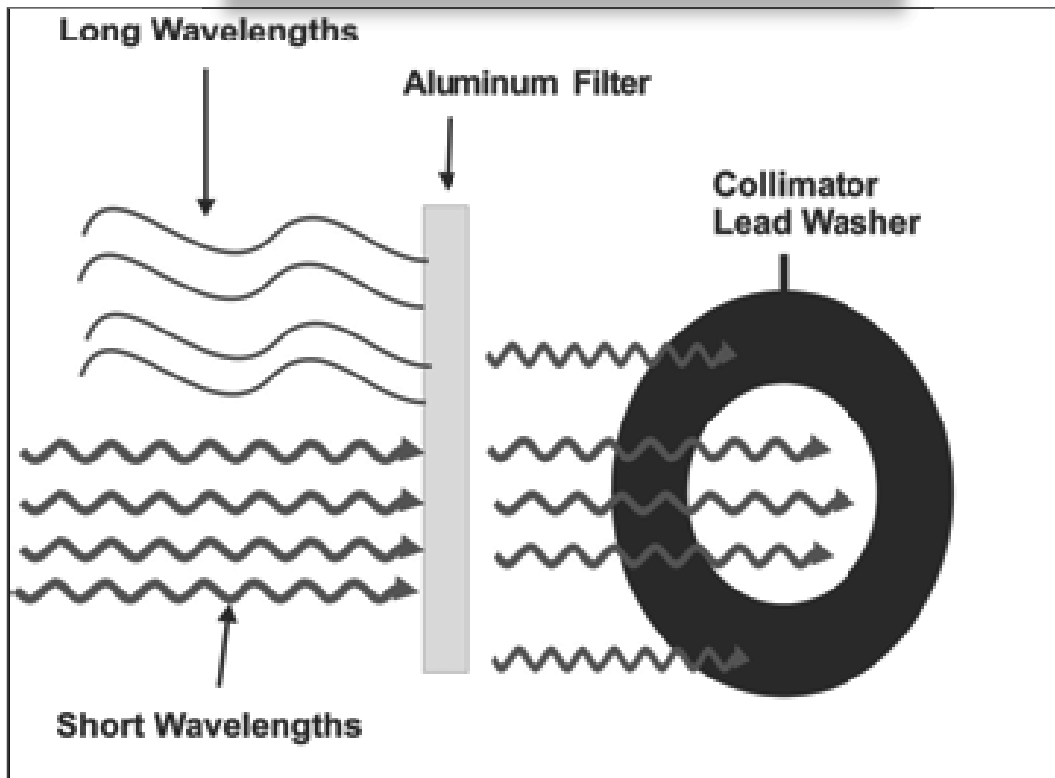




## 2. Collimator



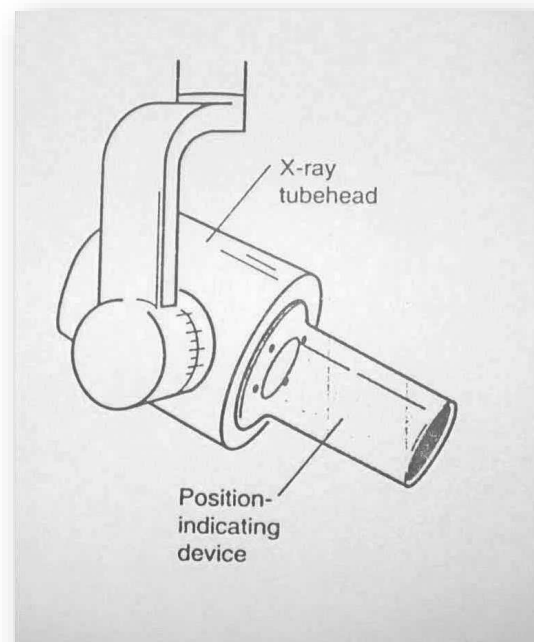
# Give Comment



## 3.Cone (PID)

Definition:

- fix the target-film distance.
- indicate the point of entry.
- delineate the direction of x-ray beam.



## 3.Cone (PID)

### Classification:

According to composition:

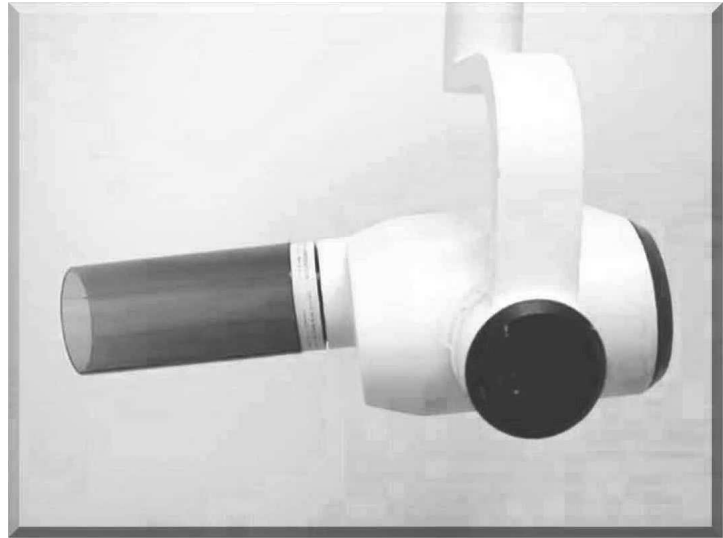
- Plastic or glass
- Metallic

According to shape:

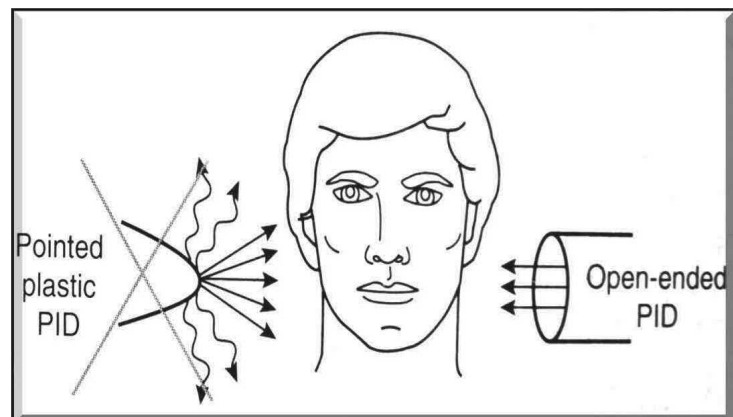
- Open end (cylindrical)
- Pointed end (conical)

According to length:

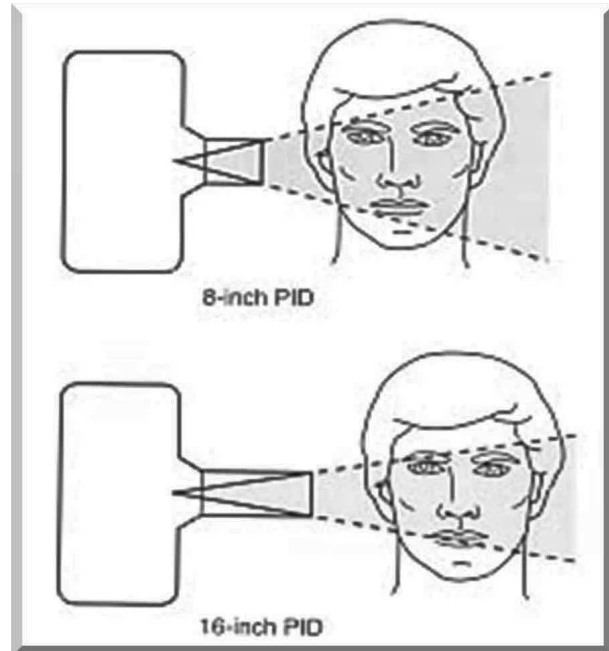
- Short (8")
- Long (16")



## 3.Cone (PID)



### 3.Cone (PID)



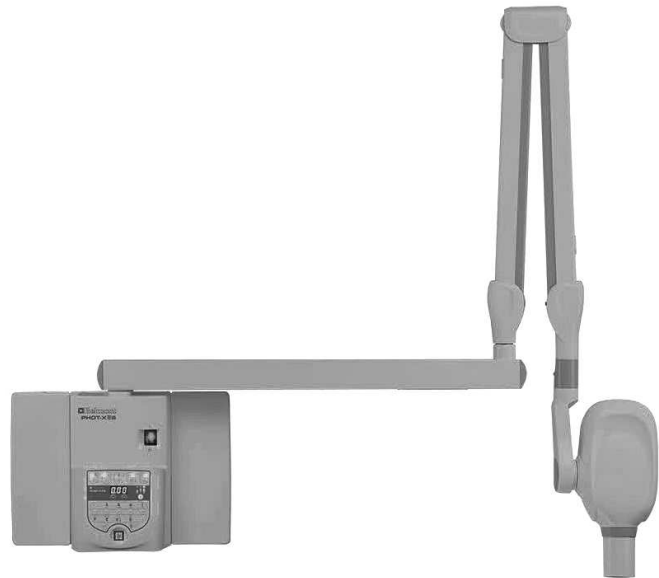
## Timer

### Definition:

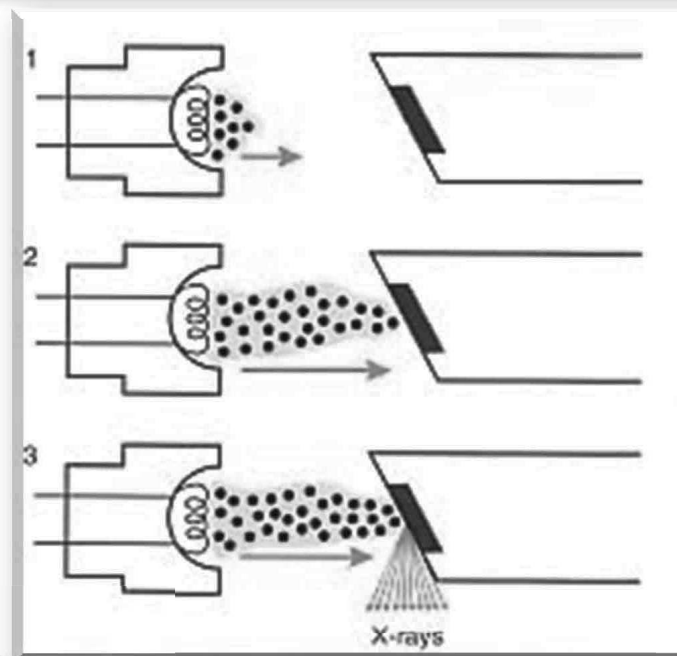
- control the exposure time.
- calibrated in fractions of seconds.

### Types:

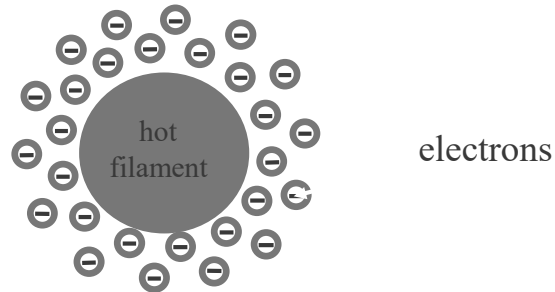
1. Automatic (electronic) timers:
  - Direct ( immediate).
  - Delayed (7-9 seconds).
2. Manual timers.



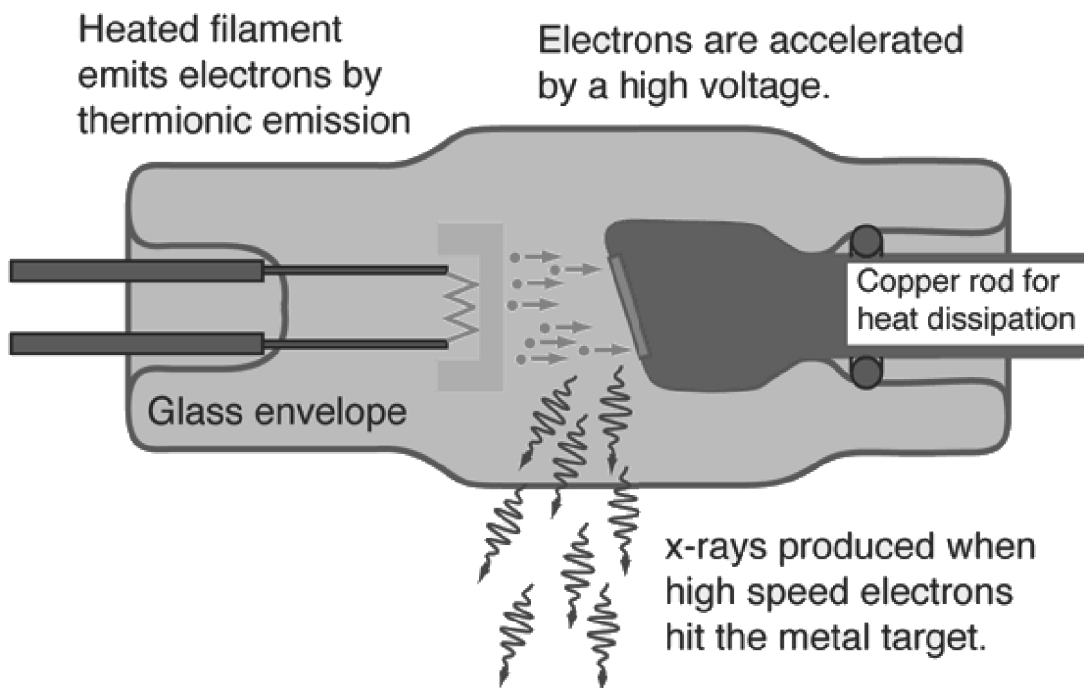
## Production of x-rays



# Production of x-rays



## Thermionic Emission



# **X-ray Production**

- **Bremmstrahlung (70%)**  
(German word of braking radiation)
- **Characteristic (30%)**



## **Parameters of X-ray Machine**

**K.V. 60 -70 (It may reach 90)**

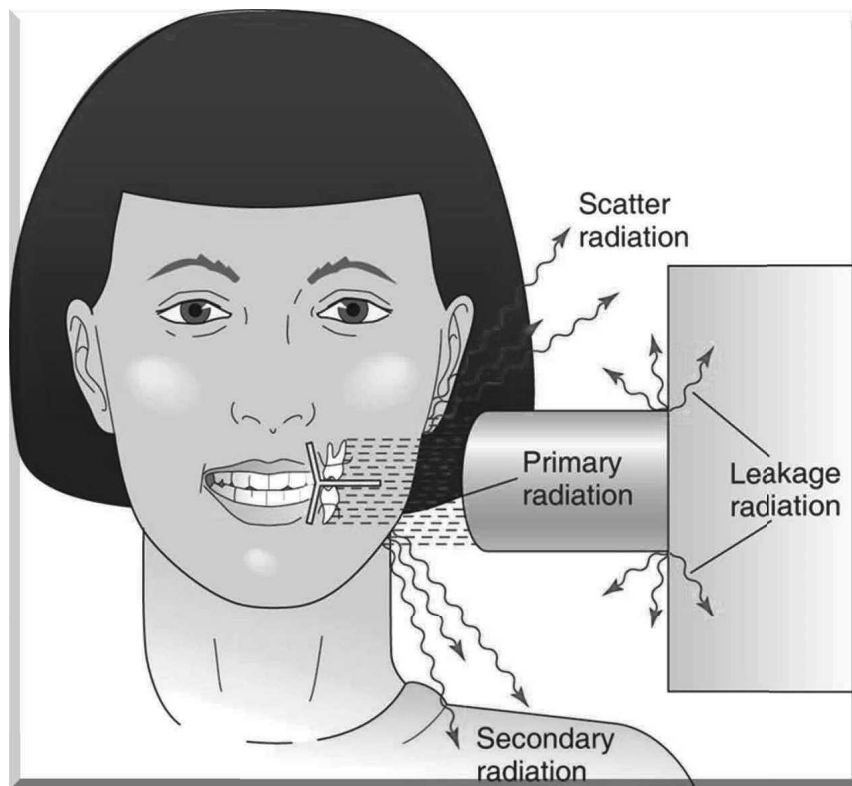
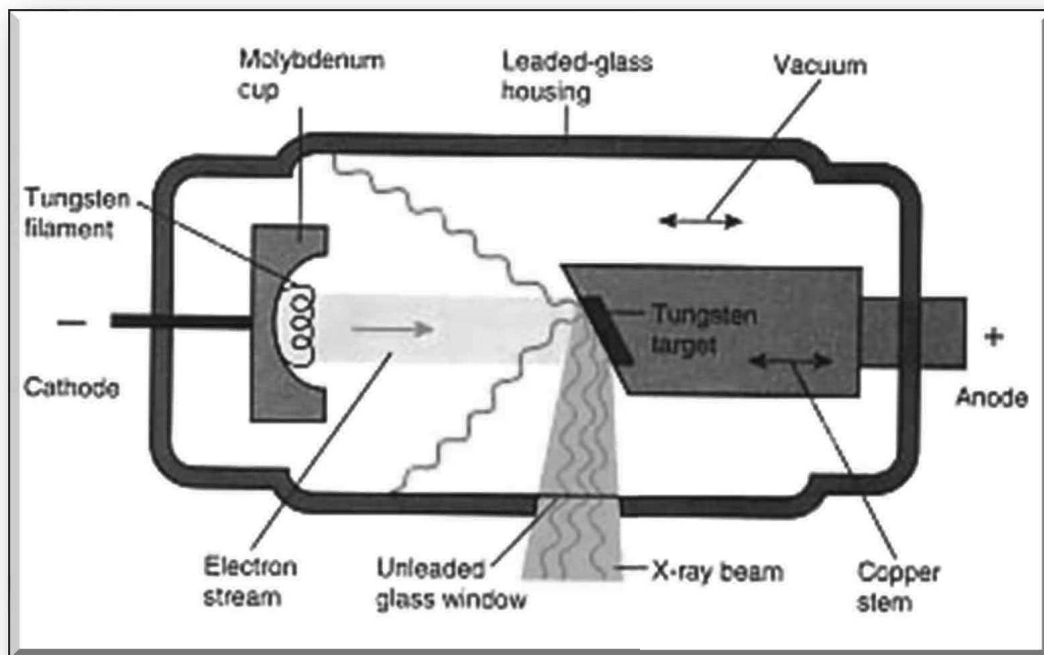
**m.A. 8 -12**

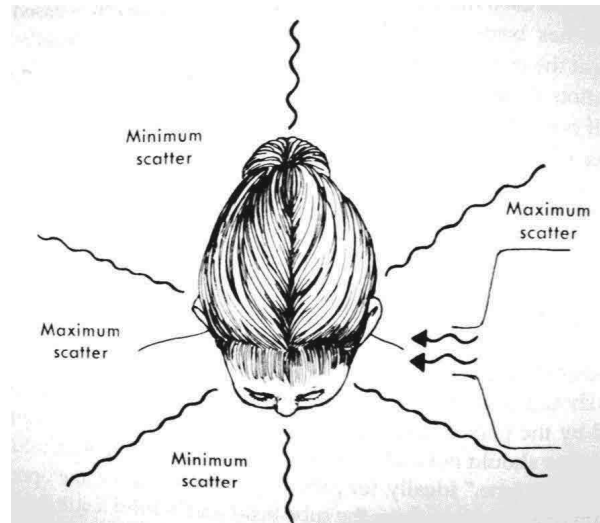
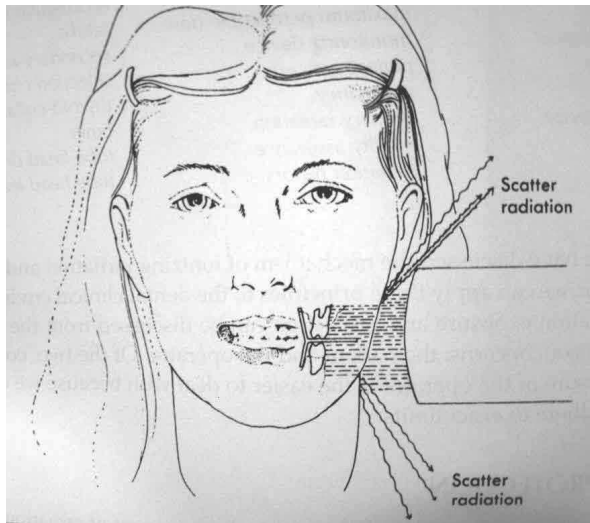


# Terminology

## Terminology

- Primary radiation.
- Useful beam.
- Secondary radiation.
- Soft radiation.
- Hard radiation.
- Scattering.
- Absorption.
- Attenuation.
- Ionization.





Scattered radiation

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Any  
Question?

